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USSR POWER TRANSMISSION EXPERIMENTS

/Comment: The following information originally appeared in the 1 December 1951 issue of the German periodical Elektrotechnik and Maschinenbau./

The USSR is confronted with the problem of transmitting large amounts of power over distances up to approximately 1,000 kilometers. With regard to cost, comparative calculations have been made for 220-, 400- and 440-kilovolt systems. Although much work is yet to be accomplished, it is already evident that the present limitations for the transmission of alternating current are determined more by economic considerations than by technical difficulties.

In accordance with the results of the experimentation, a 400-kilovolt maximum operational voltage is recommended for the transmission of power in excess of 1,000 megawatts for distances of 1,000-1,200 kilometers. The transmission capacity of the cables is increased by the use of multiple conductors and series condensers. Corona losses exert a great influence on the economy. In view of the weather and elevation conditions prevalent in European USSR, it is estimated that the annual average of corona losses amounts to 2.4 kilowatts per kilometer per phase with 2 x 400-square-millimeter duplex conductors, 1.52 kilowatts per kilometer with 2 x 500-square-millimeter duplex conductors, and 1.30 kilowatts per kilometer with 2 x 600-square-millimeter duplex conductors. Multiple conductors with three or four conductors per phase are recommended in special cases, when an increase in transmission capacity without the use of series condensers is desired.

The steel towers, which are Y-shaped, stand on concrete bases (see appended figure). The phase separation is 11.7 meters and the towers are generally 30 meters high. /These dimensions are given in the appended figure as 11.0 and 33.7 respectively./ Two ground wires are used. The average span is 400-500 meters, and the weight of the steel is thus approximately 21 tons per kilometer for a line with 2 x 400-square-millimeter cables.

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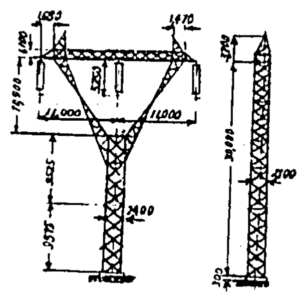
Annual cost of amortization, operation, and maintenance would amount to 8 percent for the transmission lines and 10 percent for the transformer substations.

For a distance of 300 kilometers, a 220-kilovolt operational voltage is most favorable up to 600 megawatts, whereas for larger wattages, 220 or 400 kilovolts are equally satisfactory. However, it is believed that for a distance of 300 kilometers, 220 kilovolts should be used up to 1,500 megawatts since thus there will be the least capital outlay in the initial stages.

For a load of less than 500 megawatts, 220 kilovolts is best up to a distance of 600 kilometers. For a distance of 600 kilometers and for power in excess of 700 megawatts, 400-kilovolt transmission is 10 to 15 percent less expensive than the use of 220 kilovolts with series condensers and 25 to 30 percent less expensive than 220 kilovolts without series condensers.

Since it has been found that 220- and 400-kilovolt transmission are relatively equally satisfactory within a wide power and distance range, it is considered to be not feasible to introduce an intermediate voltage between 220 and 400. Furthermore, it is not thought worthwhile to use operational voltages of over 400 kilovolts. With an annual utilization of 5,000 hours, the most economical current density for maximum power is 0.5 - 0.6 ampere per square millimeter of copper conductor. It pays to install series condensers for power in excess of 800 megawatts and for distances greater than 600 kilometers.



Tower for 400 Kilovolt Line

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